CLAIMS

1. A dynamic gain flattening filter configured to receive an optical signal, comprising:

a first filter stage including,

a first tunable coupling member;

a first differential delay with first and second tunable delay paths; and

wherein the first tunable coupling member adjusts an amount of power of the optical signal divided onto the first and second tunable delay paths of the first differential delay.

2. The filter of claim 1, wherein the first differential delay includes a fixed portion and a tunable portion.

3. The filter of claim 1, wherein the first differential delay includes a first fixed differential delay and a first tunable differential delay with respect to the first and second tunable delay paths.

4. The filter of claim 3, wherein the first fixed differential delay sets a periodic variation in a power spectrum of the optical signal.

5. The filter of claim 3, wherein the first tunable differential delay sets a phase of the periodic variation in the power spectrum of the optical signal.

6. The filter of claim 3, wherein the first fixed differential delay is positioned between the first tunable coupling member and the first tunable differential delay.

7. The filter of claim 3, wherein the first tunable differential delay is positioned between the first tunable coupling member and the first fixed differential delay.

8. The filter of claim 1, further comprising:

a second stage including:

a second tunable coupling member ;

a second differential delay with first and second tunable delay paths; and

wherein the second tunable coupling member adjusts an amount of power of the optical signal divided onto the first and second tunable delay paths of the second differential delay.

9. The filter of claim 8, wherein the second differential delay includes a fixed portion and a tunable portion.

10. The filter of claim 8, wherein the second differential delay includes a second fixed differential delay and a second tunable differential delay with the first and second tunable delay paths.

11. The filter of claim 10, wherein the second fixed differential delay sets a periodic variation in a power spectrum of the optical signal.

12. The filter of claim 10, wherein the second tunable differential delay sets a phase of the periodic variation in the power spectrum of the optical signal.

13. The filter of claim 10, wherein the second fixed differential delay is positioned between the second tunable coupling member and the second tunable differential delay.

14. The filter of claim 10, wherein the second tunable differential delay is positioned between the second tunable coupling member and the second fixed differential delay.

15. The filter of claim 3, wherein each of the differential delays is a polarization dependent differential delay.

16. The filter of claim 3, wherein the first fixed differential delay generates a time delay between first and second polarizations of the optical signal.

17. The filter of claim 3, wherein the first tunable differential delay changes an optical phase between first and second polarizations of the optical signal.

18. The filter of claim 3, wherein the first tunable coupling member is a polarization state transformer that transform the incoming signal beam from one polarization state to a different polarization state.

19. The filter of claim 3, wherein the first tunable differential delay modifies first and second polarizations of the optical signal with different phase relationships.

20. The filter of claim 3, wherein the first tunable coupling member includes first and second liquid crystal alignment members coupled to a voltage source.

21. The filter of claim 20, wherein liquid crystals in the first and second liquid crystal alignment members are orientated at different angles with respect to each other.

22. The filter of claim 20 wherein liquid crystals in the first and second liquid crystal alignment members are orientated at the same angle with respect to each other.

23. The filter of claim 20, wherein liquid crystals in the first liquid crystal alignment member are orientated orthogonal to liquid crystals in the second liquid crystal alignment member.

24. The filter of claim 3, wherein the first tunable differential delay includes first and second liquid crystal alignment members coupled to a voltage application member.

25. The filter of claim 24, wherein liquid crystals in the first and second liquid crystal alignment members are orientated at the same angle.

26. The filter of claim 24, wherein liquid crystals in the first and second liquid crystal alignment members are orientated at different angles with respect to each other..

27. The filter of claim 3, wherein at least one of the tunable coupling members and the tunable differential delays is a liquid crystal tuning element.

28. The filter of claim 3, wherein at least one of the tunable coupling members and the tunable differential delays is a Faraday rotation member.

29. The filter of claim 3, wherein at least one of the tunable coupling members and the tunable differential delays is an electro-optic member.

30. The filter of claim 3, wherein at least one of the tunable coupling members and the tunable differential delays is a thermal tuning member.

31. A dynamic gain flattening filter configured to receive an optical signal, comprising:

a first filter stage including,

a first tunable coupling member;

a first differential delay with first and second tunable delay paths;

wherein the first tunable coupling member adjusts an amount of power of the optical signal divided onto the first and second tunable delay paths of the first differential delay and

a first polarization splitter positioned adjacent to the first filter stage, the first polarization splitter splitting the optical signal into two orthogonal polarizations.

32. The filter of claim 31, wherein the first differential delay includes a fixed portion and a tunable portion.

33. The filter of claim 31, wherein the first differential delay includes a first fixed differential delay and a first tunable differential delay with the first and second tunable delay paths.

34. The filter of claim 33, wherein the first fixed differential delay sets a periodic variation in a power spectrum of the optical signal.

35. The filter of claim 33, wherein the first tunable differential delay sets a phase of the periodic variation in the power spectrum of the optical signal.

36. The filter of claim 31, wherein the first polarization splitter is a polarization walk-off crystal.

37. The filter of claim 31, wherein the first polarization splitter is a polarization beam splitter.

38. The filter of claim 33, wherein the first fixed differential delay is positioned between the first tunable coupling member and the first tunable differential delay.

39. The filter of claim 33, wherein the first tunable differential delay is positioned between the first tunable coupling member and the first fixed differential delay.

40. The filter of claim 31, further comprising:

a first half-wave plate positioned between the first polarization splitter and the first stage.

41. The filter of claim 31 , further comprising:

a second stage including:

a second tunable coupling member ;

a second differential delay with first and second tunable delay paths; and

wherein the second tunable coupling member adjusts an amount of power of the optical signal divided onto the first and second tunable delay paths of the second differential delay.

42. The filter of claim 41, wherein the second differential delay includes a fixed portion and a tunable portion.

43. The filter of claim 41, wherein the second differential delay includes a second fixed differential delay and a second tunable differential delay with the first and second tunable delay paths.

44. The filter of claim 43, wherein the second fixed differential delay sets a periodic variation in a power spectrum of the optical signal.

45. The filter of claim 43, wherein the second tunable differential delay sets a phase of the periodic variation in the power spectrum of the optical signal.

46. The filter of claim 43, wherein the second fixed differential delay is positioned between the second tunable coupling member and the second tunable differential delay.

47. The filter of claim 43, wherein the second tunable differential delay is positioned between the second tunable coupling member and the second fixed differential delay.

48. The filter of claim 43, further comprising:

a second polarization splitter positioned adjacent to the first stage, the second polarization splitter combining the two orthogonal polarizations.

49. The filter of claim 48, further comprising:

a first half-wave plate positioned between the first polarization splitter and the first stage; and

a second half-wave plate positioned between the second walk-off crystal and the second stage.

50. The filter of claim 48, wherein the first and second orthogonal polarizations of the optical signal travel independently through the first and second tunable differential delays.

51. The filter of claim 43, wherein each of the differential delays is a polarization dependent differential delay.

52. The filter of claim 43, wherein the first fixed differential delay generates a time differential delay between first and second polarizations of the optical signal.

53. The filter of claim 43, wherein the first tunable differential delay changes an optical phase between first and second polarizations of the optical signal.

54. The filter of claim 43, wherein the first tunable coupling member is a polarization state transformer that transform the incoming signal beam from one polarization state to a different polarization state.

55. The filter of claim 43, wherein the first tunable differential delay modifies first and second polarizations of the optical signal with different phase relationships.

56. The filter of claim 43, wherein the first tunable coupling member includes first and second liquid crystal alignment members coupled to a voltage source.

57. The filter of claim 56, wherein liquid crystals in the first and second liquid crystal alignment members are orientated at different angles with respect to each other.

58. The filter of claim 56, wherein liquid crystals in the first liquid crystal alignment member are orientated at 0 ° and the liquid crystals in the second liquid crystal alignment member are orientated at 90 °.

59. The filter of claim 43, wherein the first tunable differential delay includes first and second liquid crystal alignment members coupled to a voltage application member.

60. The filter of claim 59, wherein liquid crystals in the first and second liquid crystal alignment members are orientated at the same angle.

61. The filter of claim 59, wherein liquid crystals in the first and second liquid crystal alignment members are orientated at an orthogonal angle to each other.

62. The filter of claim 43, wherein each of the tunable coupling members and the tunable differential delays is a liquid crystal tuning element.

63. The filter of claim 43, wherein at least one of the tunable coupling members and the tunable differential delays is a Faraday rotation member.

64. The filter of claim 43, wherein at least one of the tunable coupling members and the tunable differential delays is a electro-optic member.

65. The filter of claim 43, wherein at least one of the tunable coupling members and the tunable differential delays is a thermal tuning member.